NUTRITION AND HIP FRACTURES IN THE ELDERLY

A Pilot Study Research Proposal

An Honors Thesis

by

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May, 1988

Expected date of graduation May, 1988

STATEMENT OF THE PROBLEM

The elderly make up an ever-increasing portion of our population. Unfortunately, there are many physiological disadvantages that accompany aging, such as undernutrition, which is a reality in the elderly. In fact, elderly "hospitalized patients recovering from femoral neck fractures were found to be eating less than 50% of nutrient requirements of protein, calcium, and vitamins, especially vitamin D, in spite of adequate food being offered them."[1] Consequently, a major source of morbidity and mortality in the elderly are fractures of the proximal end of the femur. However, the exact reason for this is unexplained.[2] The possibility of a correlation between inadequate nutrition in the elderly and the excess mortality in elderly hip fracture patients needs to be explored. Very little research has been done to discover the magnitude and implications of this probable relationship. Does immediate post-operative feeding improve the outcome for elderly patients with hip fractures requiring surgery? This research proposes to study that question, to examine the effect of immediate post-operative artificial enteral feeding on the subsequent outcome of elderly hip fracture patients.

BACKGROUND OF THE PROBLEM

A great deal of research has been done on the elderly in the two different areas of nutrition and hip fractures. Although both of these areas have been extensively studied separately, very little research has been done attempting to find the relationship between them. The research that has been carried out clearly demonstrates two phenomena. First, hip fractures in the elderly carry unusually high morbidity and mortality rates. Studies have shown that six month mortality following a hip fracture in an elderly person can reach 40%, and one year mortality figures vary from 15-67%.[3,4] Not only do hip fractures carry a significant mortality rate, but they are very common and expensive.[5] The diagnosis of fracture of the proximal end of the femur ranks tenth in terms of total patient days in a general hospital.[4,5] Therefore, these patients monetarily cost the hospital a great deal. Hence, if a treatment was found that could decrease the length of stay for hip fracture patients, it could save the hospital money. Thus, it is reasonable to believe that the cost of doing this research study to discover such a treatment is minor compared to the money it could potentially save the hospital in the long-run if it is successful. Second, a large part of the elderly population do not eat adequately. It has been found that "a substantial segment of the elderly population as a whole, perhaps as high as 60%, is consuming less than two-thirds of the current RDA for several important nutrients...Caloric intake itself has been noted to be below the recommended

level in many."[6] Unfortunately, following injury when nutrition may be especially important for a good outcome, many elderly still do not get adequate nutrition. In one study, it was found that food intake following a hip fracture was related to initial nutritional state. More specifically, "post-operative energy consumption was governed mainly by previous eating habits rather than by energy needs at the time." They found that mortality could only be accounted for by nutritional state; not age, fracture type, associated diseases, dementia score, marital status, or length of hospital stay.[7,8] Thus, it is not unreasonable to believe that nutrition in the elderly may play a major role in determining their outcome following a hip fracture. Although this theory appears logical, very few studies have been performed to establish it as a fact. Even less, if any, research has been done to discover possible interventions in regards to improving the nutrition of elderly hip fracture patients in hopes of improving their outcome.

In the geriatric patient, nutrition must be integrated into their overall care. Nutrition is directly related to the overall health of the elderly patient. In fact, poor nutrition in the elderly causes an increased vulnerabliity to stress, injury, infection, and disease.[1] As shown in one study, many elderly people suffer from chronic dehydration, nutrition deficient anemia, and hyponatremia, which increases their vulnerability to the trauma of injury and surgery even further.[8,9] It has been stated that "knowledge of nutritional status is essential if morbidity and mortality are to be decreased." This is due to the fact that since the role of nutrtion in health maintenance and improved recovery from disease or surgery is well recognized in the elderly, the maintenance or improvement of nutritional status has been shown to decrease morbidity and mortality.[8,10] Some have even gone so far as to state, "most, if not all, causes of morbidity and mortality have a nutritional or dietary component in terms of pathogenesis, prevention, or treatment."[11] Some proclaim "femoral neck fracture...is indeed unsolvable if medical care is directed only at treating the fracture and not the patient as a whole. A good surgical outcome requires intensive rehabilitation." They suggest this rehabilitation start as early as the day after surgery and that in this rehabilition, attention to nutrition is essential for a good outcome.[11] The suggested emphasis on nutrition in elderly hip fracture patients is very appropriate considering that nutrition is the factor most readily subject to human control in contributing to overall health.[13]

Poor nutrition could be contributing to the majority of complications following hip fracture surgery. The most common complications are infection, thromboembolism, pneumonia, decubitus ulcers, confusion, and

dehydration.[2,12,14] Nutrition affects the rate of infection and decubitus ulcers due to its effect on the immune response.[1,3,10] Poor nutrition can cause decreased sensitivity of pulmonary chemoreceptors to increased carbon dioxide levels and hypoxia, decreased respiratory rate, decreased tidal volume, decreased vital capacity, and decreased respiratory efficiency, thus, predisposing the patient to pneumonia.[10] Mental status is also affected by nutrition. Hence, it is reasonable to believe that if post-operative elderly hip fracture patients receive adequate nutrition, many complications could be prevented. This, in turn, could possibly decrease the high morbidity and mortality associated with hip fractures in the elderly.

Unfortunately, many elderly hip fracture patients do not eat adequately in spite of sufficient food being offered to them.[1] It seems the very patients who are least provided with nutritional reserves to sustain them in times of trauma are least likely to eat adequate amounts and may be in great need of artificial feeding. The implications of previous research toward a correlation between nutrition and outcome for hip fracture patients, along with possible treatment, requires further exploration. A controlled trial of artifical feeding after hip fracture surgery in the elderly may help to answer the treatment question.[7,8]

OBJECTIVES

The goal of this study is to determine if immediate post-operative artificial feeding improves the outcome for elderly patients with hip fractures requiring surgery. By "immediate post-operative artificial feeding", it is meant that enteral feeding will begin 72 hours after surgery. The enteral feeding will consist of giving adequate nutrition, including vitamins and minerals, as to the patients' requirements in respect to the stress they are under. They will be fed until they are eating at least 60% of their nutritional requirements or until discharged. There will also be a control group which will not be artificially fed enterally. The goal will be attained by determining the following objectives:

In comparing the experimental group and the control group, determine if immediate post-operative artificial feeding of elderly hip fracture patients requiring surgery

1) decreases mortality
2) decreases the extent of complications and morbidity
3) decreases the length of hospital stay
4) increases the chance for discharge location to be to the home rather than a skilled care facility
5) improves performance in activities of daily living

METHODS

Population and Sample

The population will be a probability sample, in which there is equal opportunity for each subject to be placed in a group. The target population to be studied is that of elderly hip fracture patients requiring surgery. Twenty patients will be studied in the pilot study. Ten patients will be placed in the experimental group and ten in the control group. The patients will be 60-85 years of age and will be both male and female. They will be hip fracture patients requiring surgery, not elective hip prostheses, with the hip fracture having occurred as an isolated injury. The subjects must be ambulatory prior to the injury. Neither original nutritional status nor post-operative eating tendencies will solely cause exclusion from the study overall; however, patients eating adequately after surgery will not be placed in the artificial feeding group. If the patients have ongoing significant renal compromise, any type of cancer, an artificial airway, congestive heart failure or respiratory acidosis on admission, are critically ill, or have an Intensive Care Unit admission within 48 hours of general admission, they will be excluded.

Placement in the experimental group versus the control group will occur by random selection, placing every other subject in each group.

Definitions

Complications - These will be determined by a physician's diagnosis and abnormal lab values, as defined by DRGs, which will provide nationwide standardization.

Fracture type - Any fracture of the proximal end of the femur will be accepted.

Treatment type - Surgical treatment of the proximal end of the femur consisting of internal fixation by pinning or prostheses will be accepted.

Nutritional needs - These will be determined by a nutritional screen for risk of existing or potential nutritional inadequacies. (see Appendix A) A dietary history and a physical assessment will be done within 48 hours of admission. Also, a protein-calorie count will be started on admission.

Time monitored and length followed - Subjects will be monitored daily while hospitalized. After discharge, follow-up will be conducted by telephone calls every two months for up to six months.

Labs to be noted - These will consist of 24 hour UUN, Chem 12, prealbumin, lytes #2, creatinine, CBC, glucose, and possibly total iron-binding capacity.

Severe renal compromise - This will be distinguished by a creatinine level remaining above 2.0 for several days after admission.

Cancer - Any diagnosis of cancer will be excluded to prevent inclusion of pathological fractures.

Congestive Heart Failure - This will be determined by radiographic and clinical evidence on admission.

Budget - The cost of testing and feeding will be absorbed by the patient's insurance.

Research Design

The study will be performed as a true experiment. This is justified since the independent variable is a treatment that will be deliberately introduced and manipulated. The independent variable, or treatment, is artificial feeding with a Corpak. The actual feeding received and the length of time it is given will be controlled by the researcher. Every other subject will be placed in either the experimental group or the control group, which will determine whether tube feedings will be received. The study will also be randomized, pretest-posttest, control group design. Subjects will be selected and assigned randomly. They will be assessed prior to, during, and after treatment. This assessment will be a nutritional screen consisting of both dietary history and physical assessment. The dependent variable will be measured and compared before and after treatment. This dependent variable will be their overall health and outcome. This will be measured as previously explained under Objectives. If there is a significant difference, a cause and effect relationship will be established. Thus, if the artificially fed group has a better overall outcome than the non-artificially fed group, the hypothesis, artificial feeding of elderly hip fracture patients improves outcome following surgery, will be supported. Hence, a relationship between the cause (artificial feeding) and effect (imporved outcome) will be established. Temporal sequence will have been controlled by assessing, then introducing the treatment and keeping everything else constant, then assessing again. Due to the random assignment, along with assuming no untoward effects of the treatment occur and few subjects drop out of the study, fewer alternative explanations will exist.

Procedures

The Nutritional Support Team will be assigned by the orthopedic surgeons to every elderly hip fracture patient requiring surgery. (see Appendix B) Weight history and nutritional status will be assessed prior to surgery. Seventy-two hours after surgery, their eating will be assessed. On that basis, they will be assigned to either the experimental or control group, or they will be excluded from the study. If at 72 hours post-op the experimental group patients are not eating at least 60% of their estimated requirements, they will receive Corpak tube feedings. If the patient is eating adequately on his or her own prior to discharge, the tube feedings will be stopped at that time. If the patient does not eat adequately, they will receive supplemental feedings until discharge. In elderly hip fracture patients there is a disproportionate number of females to males; therefore, the majority of the subjects will be female to provide a more accurate representation of the general population of elderly hip fracture patients.

Ten patients will be assigned to the experimental group. These will all be patients who are eating inadequately and will receive artificial enteral feeding. Ten patients will be assigned to the control group. These patients will not receive artificial enteral feeding. Most of these patients will not be eating adequately. Up to 4 out of the 10 may be eating adequately to allow further comparisons. The groups will be monitored and assessed daily while in the hospital. They will be monitored by telephone calls every two months after discharge for up to six months. The telephone calls will be made by members of the Nurtitional Support Team. They will ask the patient about morbidity and ability in activities of daily living. The data collected and recorded will consist of the patients' medical diagnosis, medications taken, feeding formula composition, patient tolerance, all intake by mouth, associated complications, mortality, length of hospital stay, discharge location, nutritional status, and performance in activities of daily living. Data will then be organized into nominal data to determine statistical significance. To analyze the data, Chi-square and correlational statistical procedures will be used.

Instrumentation

-Nutritional assessments to measure nutritional status
-Lab values
-X-rays to measure bone healing
-Physical therapy assessment of performance in activities of daily living

The accuracy and consistency of the measurements by these instruments has already been established; thus, their high reliability has been accepted.

Assumptions

-Male versus female subjects' bone healing rate is assumed to be the same.
-Effect of osteoporosis is assumed to be minimal.
-Complete bone union is assumed to occur.

Although these will be assumed, demographic data will be collected to assess them.

Limitations

-Ongoing disease processes may have an effect and perhaps would encourage further exploration.
-Male versus female subjects' bone healing rate, along with osteoporosis could affect outcome and will be tracked.
-As age increases, the chance for a successful outcome decreases.
-If the hip is dislocated for an extended length of time, the outcome could be affected.
-Medical History, socioeconomic level, and discharge care, could all also affect outcome.

VALIDITY

The nature of this research study gives it a high degree of validity. The study will be performed as a true experiment with the independent variable of artificial feeding being controlled. This will allow a cause and effect relationship to be established between artificial feeding and an elderly hip fracture patient's outcome. However, other than the previously mentioned reasons for exclusion, the patient's medical history will not cause them to be excluded from the study. Thus, there could be alternative explanations for their outcome due to certain ongoing disease processes. These explantions should, however, be minimal due to the size of the study. Since there will be very little discrimination on the basis of ongoing disease, the sample will be representative of the general population. The findings should, therefore, be able to be generalized from the sample to the entire population. Thus, the intervention of tube feeding should work in other settings with other patients. Hence, the results of this study should broadly apply to the general population of elderly hip fracture patients requiring surgery.

ETHICS AND PROTECTION OF HUMAN SUBJECTS

The first consideration of ethics and protection of human subjects is that of physical or mental harm. Enteral nutritional support is a standard procedure and is accepted as a safe and effective method of artificially administering nutrition. Tube feedings are safely tolerated by most patients, and their use is simple and associated with minimal morbidity. In comparison with intravenous alimentation, enteral support is more economical, is more physiologic, is easier to insert, and has fewer associated complications.[15,16] Although the occurrence of these complications is acceptably low, they must be taken into consideration. The associated complications can be placed into three categories of gastrointestinal, mechanical, and metabolic.[15,17] In one study, it was found that only 11.7% of the patients experienced either GI (6.2%), mechanical (3.5%), or metabolic (2.0%) complications. Gastrointestinal complications, which are the most common, consist of nausea, vomiting, abdominal cramping, and diarrhea. The assistance of infusion pumps should decrease GI complications. The most common mechanical complications are tube occlusion and dislodgement, esophageal erosion, and pulmonary aspiration of gastric contents.[4,17] Tube occlusion should be prevented and relieved by periodic flushing. Esophageal erosion should be avoided by using small lumen feeding tubes. The risk of aspiration pneumonia will be decreased by elevating the head of the bed at a 30 degree angle at all times.[15] There have been rare cases of feeding tubes being inserted improperly, penetrating into the lung, pleural space, nasopharynx, esophagus, stomach, and brain; introducing infection, bleeding, or air into the closed space. However, this usually occurs in high-risk patients, who are patients that are uncooperative, critically ill, receiving mechanical ventilation, have a decreased level of consciousness, have a decreased gag reflex or tracheobronchial sensation, or are on neuromuscular blocking drugs.[16,18] As previously stated, none of these types of high-risk patients will be included in the study. Also, the feeding tubes will only be inserted by qualified personnel using non-forceful insertion of feeding tubes without stylets, checking placement, and observing carefully for respiratory distress.[15,16,18] Metabolic complications consist of fluid and electrolyte imbalances. However, enteral metabolic complications are usually less severe than parenteral due to the buffering effects of the gut. Patients with significant renal compromise are at higher risk for metabolic problems; however, they will not be included in the study. Impending metabolic complications should be alleviated by careful monitoring and appropriately changing feeding composition as necessary. Even though these possible complications exist, the benefits of tube feeding still definitely outweigh the risks. Enteral feeding is a safe and effective way of reversing protein-calorie malnutrition, which has been found

to occur in up to 50% of the patients on general medical and surgical units.[17] Correct use of enteral feeding has been proven to promote nitrogen retention, restore cell-mediated immunity, accelerate wound healing, and improve overall nutritional status.[15] Thus, although there is a minimal risk for complications with enteral feeding, the chance for improving overall outcome for elderly hip fracture patients is much greater. Hence, a new question is raised. In view of the decreased risk and probable significant benefits, is it ethical to not artificially feed the undernourished patients in the control group? Even though previous research implies that tube feeding elderly hip fracture patients could be of great value to them, it has not yet been established. Since currently it is not standard procedure to tube feed elderly hip fracture patients who are not eating adequately, it is ethical to artificially feed only the experimental subjects in the study.

The second consideration is that of voluntary participation. The study will only consist of those patients who cooperate voluntarily. Informed consent will be employed. Patients will be informed about the nature of the study, probable benefits, and possible complications, then their voluntary consent will be secured. (see Appendix C)

The last consideration is the right of the participants to have their privacy protected. The information obtained during the study will under no circumstances be publicly disclosed in a manner that would identify any specific person. Thus, the participants will be guaranteed confidentiality, and will remain anonymous except to those working directly with the patients in the study. Indentification numbers will be substituted for the subjects' names on study records to prevent any accidental breach of confidentiality.

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APPENDIX A

Hospital Malnutrition and How To Assess The Nutritional Status of a Patient

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Hospital Malnutrition and How To Assess The Nutritional Status of a Patient

No one is certain if hospital induced malnutrition has always been with us and is just now being recognized by newly nutrition conscious physicians or whether it is an unexpected byproduct of the sophisticated food service systems now popular in institutions. Regardless of etiology, hospital malnutrition is a prevalent health problem with serious professional and legal implications. The following instructional essay tells how to recognize undernourished, malnourished, or starving patients. It is the result of the combined effort of two teams of professionals. It was nearly a year in preparation. Its reliable guidelines should be helpful in every hospital. To make this vital information useful to all, this article is also available as a Nutrition Today Teaching Aid.

by CHARLES E. BUTTERWORTH, M.D. and GEORGE L. BLACKBURN, M.D., Ph.D.

Three recent developments make it important that physicians, dietitians, nurses, administrators, and in fact all persons involved in patient care, become aware of the nutritional status of the hospital patient.

First, there is the recognition that an alarming number of people in hospitals are malnourished and that this condition is preventable in many cases.

Second, more and more health professionals are beginning to appreciate the fact that good nutrition plays a major role in wound healing and in heightening resistance to infection.

Lastly, new techniques and products have been developed which greatly enhance the ability to provide nutritional support to the patient.

One might wish to extend this list of developments that call for greater awareness of the nutritional health of hospitalized patients. Among such points would be that because of the level of current food prices it is likely that more poor people and indigent elderly are apt to be undernourished when they enter the hospital. On the other hand, moreover, with the current high costs of hospitalization, there is incentive for shortening the period of confinement by preventing complications and hastening convalescence, as proper attention to the patients' nutritional health will surely do.

Our purpose here is to outline some simple and practical methods for the assessment of nutritional status. Most of these can be applied without complicated laboratory equipment and they should be available in hospitals of all sizes, clinics, and even in doctor's offices. Many of the procedures involve nothing more than the application of basic clinical skills, careful inspection of the patient with nutrition in mind, and the use of analytical interviews of the nature described.

No attempt will be made to outline programs of nutritional support or therapy. The major intent here is to suggest methods and guidelines that will make it easier to identify those patients who are in need of nutritional intervention.

Not the least of our purposes in presenting these guidelines is the hope that some of the following suggestions will result in improved systems for dealing with nutrition services in hospitals according to local requirements. As Dr. Meiling aptly pointed out (*Nutrition Today*, May/June 1974), "This (hospital malnutrition) is not only the doctor's and dietitian's problem, it is also the administrator's problem." He also noted that the root cause of hospital-induced malnutrition "lies in the hospital system, and until that's changed, patients are going to suffer."

RARE CURIOSITIES

It is our belief that malnutrition has for too long been identified with the "classical" vitamin deficiency syndromes by physicians and other health professionals. Although these far-advanced syndromes are occasionally encountered and should not be missed, overt vitamin deficiencies are best regarded as rare medical curiosities. By contrast, protein-calorie malnutrition, which henceforward will be referred to by the abbreviation "PCM", which develops in the hospital, has been found to affect from one-fourth to one-half of medical and surgical patients whose illness has required hospitalization for two weeks or more. Therefore, high priority should be given to the identification and prevention of PCM.

Patients with malnutrition, particularly protein-calorie malnutrition, do not tolerate concurrent illness well. They tend to have delayed wound healing and greater susceptibility to infection and other complications, so that the period of hospitalization may be considerably prolonged. It is perhaps paradoxical that for twenty-five years or more a certain preoccupation with fluid and electrolytes, vitamins, hormones,

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and blood gases has appeared to divert the average clinician's attention from two of the most fundamental requirements of every patient: adequate protein and sufficient calories. Why has this occured? The reason probably is that there is no single anthropometric or biochemical measurement to define the exact extent of PCM. Nevertheless, as with any other complex pathological process, the patient in whom PCM is suspected, should be evaluated using a number of accurate methods and techniques that have proved both valuable and practical in our experience for the assessment of a patient's nutritional status (and risk). Considerable emphasis will be placed on PCM because of the prevalence of the problem. However, it is believed that the procedures to be described are sufficiently comprehensive to permit identification of most of the common nutritional disorders that are likely to be encountered in a hospital population.

EVERYONE'S DUTY

It should be a simple matter, except in emergency situations, to obtain rather quickly an estimate of a patient's nutritional health when he is admitted to the hospital. Such an estimate should be an essential part of the admitting process. It can be carried out by the clerical staff, nurses, laboratory personnel or others. In this regard, in addition to inquiring as to the patient's usual height and weight, it is essential that the patient should be weighed and his height measured. Asking the patient for this information is not sufficient because, for a variety of reasons, the reply will very likely be inaccurate and two valuable benchmarks of nutritional health will be lost. The actual measurements should be recorded alongside the desirable weight according to some suitable standard such as Metropolitan Life Insurance tables. The physician should bear responsibilty for reviewing this information along with admission laboratory work.

It should be the duty of every person involved in the patient's care, to ensure that crucial data are recorded and available for interpretation. Patients at high risk of malnutrition or having particular nutritional problems should be identified within twenty-four hours by a notation made in the patient's permanent hospital record. We believe that this information should be communicated simultaneously and directly to a Nutrition Support Service or to other appropriate authorities having responsibility for this aspect of patient care. But since it is an unusual hospital indeed that has yet organized a Nutrition Support Service, our suggestion is that in the absence of such a service, the matter be referred to the staff member most interested in nutrition and to the dietitians.

TABLE 1

CHECK LIST FOR ASSESSMENT OF NUTRITIONAL STATUS

Part 1

(To be completed by trained staff member, physician's assistant, or other)

	YES	NO
Usual body weight 20% above or below desirable?		
Recent loss or gain of 10% of usual body weight?		
Any evidence that income and meals are not adequate for needs:		
More than half of meals eaten away from home?		
Does patient live alone and prepare own meals?		
Ill fitting dentures?		
Excessive use of alcohol?		
Frequent use of fad diets, or monotonous diets?		
Any chronic disease of GI tract? (describe)		
Has there been any surgical procedure on GI tract (other than appendectomy? (describe)		
Recent major surgery, illness, or injury?		
Recent use of large doses of:		
catabolic steroids?		
immunosuppressants?		
anti-tumor agents?		
anti-convulsants?		
anti-biotics?		
oral contraceptives?		
vitamins?		
other?		
Has patient been maintained more than 10 days on intravenous fluids?		
Any reason to anticipate that patient will be unable to eat for 10 days or longer?		
Is patient known to have:		
diabetes?		
hypertension?		
hyperlipidemia?		
coronary artery disease?		
malabsorption?		
chronic lung disease?		
chronic renal disease?		
chronic liver disease?		
circulatory problem or heart failure?		
neurological disorder or paralysis?		
mental retardation?		

(Note: If all answers to the above items are "No", the patient may be regarded as a "low-risk" or "acceptable risk." The risk increases in direct proportion to the number of "Yes" answers. Patients with more than 3 "Yes" answers should be considered at an increased risk of developing medical complications, unless special attention is given to providing their nutritional requirements.)

Part 2

(To be completed by dietitian)

Description of recent food consumption patterns, eating habits, and meal composition.
Circumstances of food purchase, storage and preparation in the home.
Estimate of daily average caloric consumption.
Estimate of energy expenditure (e.g. low, average, or high level of physical activity).
Estimate of possible nutrient deficiencies, based on suspected imbalances.
Food tray viewed

Part 3

(To be completed by nursing staff)

Estimate of actual food consumption, including any provided by non-hospital sources.
Estimate of fluid intake.
Estimate of stool frequency, urinary losses, losses by suction tube, drainage, etc.
Behavior patterns, eccentricities, vomiting (including surreptitious vomiting).
Careful recording of body weight at regular intervals.

The attending physician must bear the ultimate responsibility for determining the patient's nutritional requirements and providing a means to supply them under the circumstance dictated by the clinical situation. His function is catalytic since without his initiative the ancillary resources of the hospital cannot be activated on behalf of the patient. Only on his signal can the special skills of nurses, dietitians, pharmacists, and consultants be brought to bear on the problem at hand. If these services are inadequate, the physician should resolutely send the patient to another hospital capable of providing whatever nutritional support services are necessary to sustain the patient during his illness. It is the responsibility of

TABLE 2

THE PHYSICAL EXAMINATION

General appearance—obese? skinny?
Head—bossing, deformities, craniotabes (under 1 year old)
Eyes—ophthalmoplegia, cataracts, xerosis, Bitot's spots, retinal hemorrhage, papilledema, night blindness
Mouth—glossitis, gingivitis, caries, periodontal disease, cheilosis, ageusia, dysgeusia
Nose—anosmia, dysosmia, nasolabial seborrhea
Skin—pallor, abnormal pigmentation (carotenemia, hemochromatosis), follicular hyperkeratosis, bruises, peri-follicular petechiae, pellagrous dermatitis, flaky-paint dermatitis, fistulas, status of wound healing, subcutaneous fat and skin-fold thickness, edema
Hair—easy-pluckability, sparseness, depigmentation
Nails—friability, bands and lines
Neck—goiter
Heart—enlargement, high-output failure, resting tachycardia
Lungs—none? Use of accessory muscles to breathe?
Abdomen—enlarged (fatty) liver, distended loops of bowel, ascites, varices
Genito-urinary—secondary sexual characteristics, hypogonadism, delayed onset of puberty
Skeletal—epiphyseal thickening, bowing, rachitic rosary, osteoporosis, frog leg position, tenderness
Muscle—atrophy, wasting, hemorrhage, pain
Joints—effusions, arthralgia
Neurol—foot drop, confabulation, improper position and vibratory sense, hyperreflexia, hyporeflexia, irritability, convulsions

TABLE 3

EXAMPLES OF SOME "HIGH-RISK" PATIENTS

1. Patients who are grossly overweight, or grossly underweight (the former because of a tendency on the part of some physicians to overlook protein requirements; the latter because of limited protein reserves in organs and lean body mass)
2. Any patient with prior maldigestion, malabsorption, or inadequate nutrient intake, e.g.
   a. pancreatic insufficiency
   b. celiac disease; Crohn's disease; surgical removal of portions of stomach or small bowel; small bowel by-pass, congenital malformations of GI tract
   c. chronic alcoholism, anorexia nervosa; any form of dietary faddism or abuse
   d. patients maintained for more than 10 days on simple solutions of glucose and saline
3. Patients with increased metabolic requirements, e.g. fever, infection, trauma, hyperthyroidism, pregnancy, burns, infancy
4. Patients with external losses, e.g. draining fistulas, wounds, abscesses, effusions, exudative enteropathies, chronic blood loss; chronic renal dialysis
5. Any patient who is likely to be unable to consume adequate amounts of food for 10 days (especially if reserves are limited), e.g. head and neck trauma; injury or surgery involving GI tract.

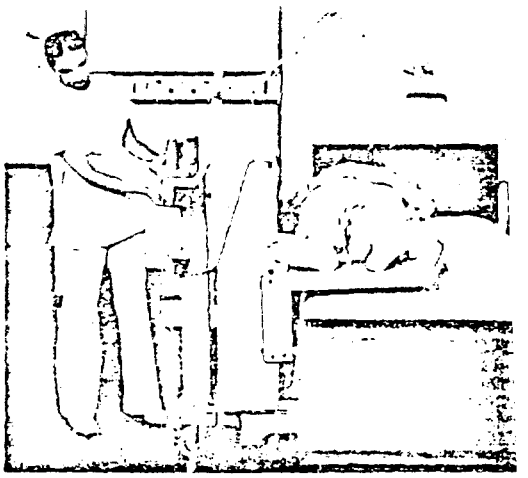

Fig. 1 Patient being weighed on balance scales suitable for use with bed patients who are unable to stand. Scales of this type are available from Acme Scale Co., Oakland, California.

TABLE 4

DESIRABLE WEIGHTS FOR MEN AND WOMEN

According to height and frame. Ages 25 and over

Height (in shoes)*	Weight in pounds (in indoor clothing) Men Small frame	Medium frame	Large frame
5 ft 2 in	112-120	118-129	126-141
5 ft 3 in	115-123	121-133	129-144
5 ft 4 in	118-126	124-136	132-148
5 ft 5 in	121-129	127-139	135-152
5 ft 6 in	124-133	130-143	138-156
5 ft 7 in	128-137	134-147	142-161
5 ft 8 in	132-141	138-152	147-166
5 ft 9 in	136-145	142-156	151-170
5 ft 10 in	140-150	146-160	155-174
5 ft 11 in	144-154	150-165	159-179
6 ft 0 in	148-158	154-170	164-184
6 ft 1 in	152-162	158-175	168-189
6 ft 2 in	156-167	162-180	173-194
6 ft 3 in	160-171	167-185	178-199
6 ft 4 in	164-175	172-190	182-204
	Women Small frame	Medium frame	Large frame
4 ft 10 in	92- 98	96-107	104-119
4 ft 11 in	94-101	98-110	106-122
5 ft 0 in	96-104	101-113	109-125
5 ft 1 in	99-107	104-116	112-128
5 ft 2 in	102-110	107-119	115-131
5 ft 3 in	105-113	110-122	118-134
5 ft 4 in	108-116	113-126	121-138
5 ft 5 in	111-119	116-130	125-142
5 ft 6 in	114-123	120-135	129-146
5 ft 7 in	118-127	124-139	133-150
5 ft 8 in	122-131	128-143	137-154
5 ft 9 in	126-135	132-147	141-158
5 ft 10 in	130-140	136-151	145-163
5 ft 11 in	134-144	140-155	149-168
6 ft 0 in	138-148	144-159	153-174

*1-in heels for men and 2-in heels for women.

NOTE—Prepared by the Metropolitan Life Insurance Company (1960). Derived primarily from data of the *Build and Blood Pressure Study*, 1959.

the physician to review promptly all nutrition-related information provided to him by various staff members combined with his own observations and preliminary laboratory results. This should form an important part of the patient's "data base." In the case of problem-oriented records, specific nutrition problems should be itemized on the problem list.

THREE ALLIES

For the assessment of a patient's nutritional status, the physician has three traditional allies: *the history, the physical examination, and the laboratory findings.*

Table 1, part 1 represents a check list of the more important points to be covered in the patient's history. As will be seen, the answers to these simple questions can be recorded by paramedical personnel, or family members, or possibly even by the patient himself. While this list is not exhaustive, it will serve as a screen upon which one can spot warning signals. In our experience, even one "Yes" answer should alert the physician and his staff to the presence of a person with a potential nutritional problem. Several affirmative answers immediately suggest the need for special studies, special consultations, and possibly preparation for special support measures.

Part 2 of this table outlines contributions that can be made by members of the dietetic staff. Very often the skilled questioning of an experienced dietitian can uncover unexpected facts about the patient and his food consumption patterns, either under home conditions or under the conditions of the current health problem. Careful inquiry may be necessary to determine if patients truly understand prior dietary instructions and the dietitian should be adept at eliciting these.

Part 3 of table 1 indicates the contribution that the nursing staff can be called upon to make. In this connection, the need to have regular and accurate recordings of the body weight cannot be over-emphasized. Weight is perhaps the most important single piece of information that can be provided as to the patient's nutritional status. The nursing staff is also in a unique position to maintain a constant surveillance of the patient's activities, behavior, and food consumption. Nurses are very careful to take note and record the medicines a patient takes; in some patients, the record of nutrient intake is every bit as important as the notation of drugs he has been given. If our modern hospitals are to be rid of the spectre of hospital induced malnutrition, then at least some method has to be found to note and record how well a patient eats. Whenever a patient is suspected of becoming malnourished, a glance at his fin-

ished meal tray is of great importance. The impression is an indispensible part of his hospital record.

The nursing staff's observations of a patient during the entire 24-hour day may provide invaluable information regarding nutrient intake, adherence to dietary instructions, or dietary indiscretions. For example, it can be quite helpful to learn about the midnight snack consumed by the patient on a low calorie diet; the forbidden potato chips and salted peanuts eaten by the patient on a sodium-restricted diet; or the candy bar consumed by the diabetic. Similarly the recognition of surreptitious vomiting has occasionally helped explain and otherwise puzzling case of suspected malabsorption.

Table 2 outlines some of the more prominent physical findings that the physician should look for when he is making a nutritional evaluation. This is where the skilled and experienced eye of the astute clinician is invaluable. Certainly it should be his task to search for physical evidence in suspected problem areas and to correlate physical findings with the history. A conscientious and thorough physical examination for nutritional adequacy or inadequacy should be a routine part of every patient's workup and should require no special indications or justification. The history and physical examination should enable the physician not only to identify existing problems and treat them, but also to anticipate problems and prevent them.

USEFUL INDICATORS

Measurement of the tricep skinfold techniques has proven to be a helpful indicator of nutritional status. The proper technique is to grasp a fold of skin on the posterior aspect of the arm midway between shoulder and elbow, gently pulling it away from the underlying muscle. The caliper is applied and the average of several readings is recorded on the chart. Either Lange or Harpenden calipers are suitable for this purpose, since they are designed to exert uniform pressure over a wide range of thicknesses.

The measurements of height and weight are, by far, the most useful indicators of nutritional status. In many cases, they are the only indices available outside the hospital. Although rapid weight loss in a hospitalized patient is an extremely important index of change in protein nutritional status, since it usually reflects use of protein as a metabolic fuel, (adipose tissue is lost more slowly owing to its high caloric content), a patient who is grossly obese may be above the desirable weight/height standards, yet suffer extreme protein-calorie malnutri-

TABLE 5A

TRICEPS SKIN-FOLD, BIRTH TO 60 MONTHS, SEXES SEPARATE*

Age (months)	Triceps skin-fold (mm)									
	Standard		90% standard		80% standard		70% standard		60% standard	
	M	F	M	F	M	F	M	F	M	F
Birth	6.0	6.5	5.4	5.9	4.8	5.2	4.2	4.6	3.6	3.9
6	10.0	10.0	9.0	9.0	8.0	8.0	7.0	7.0	6.0	6.0
12	10.3	10.2	9.3	9.2	8.2	8.2	7.2	7.1	6.2	6.1
18	10.3	10.2	9.3	9.2	8.2	8.2	7.2	7.1	6.2	6.1
24	10.0	10.1	9.0	9.1	8.0	8.1	7.0	7.1	6.0	6.1
36	9.3	9.7	8.4	8.7	7.5	7.8	6.5	6.8	5.6	5.8
48	9.3	10.2	8.4	9.2	7.5	8.2	6.5	7.2	5.6	6.1
60	9.1	9.4	8.2	8.5	7.3	7.5	6.4	6.6	5.5	5.7

*Adapted from Hammond (1955a); Tanner & Whitehouse (1962).

TABLE 5B

TRICEPS SKIN-FOLD, 5-15 YEARS, SEXES SEPARATE*

Age (years)	Triceps skin-fold (mm)									
	Standard		90% standard		80% standard		70% standard		60% standard	
	M	F	M	F	M	F	M	F	M	F
5	9.1	9.4	8.2	8.5	7.3	7.5	6.4	6.6	5.5	5.7
6	8.2	9.6	7.4	8.6	6.6	7.7	5.8	6.7	4.9	5.8
7	7.9	9.4	7.1	8.5	6.3	7.5	5.5	6.6	4.7	5.7
8	7.6	10.1	6.8	9.1	6.1	8.1	5.3	7.1	4.5	6.1
9	8.2	10.3	7.4	9.2	6.6	8.2	5.8	7.2	4.9	6.2
10	8.2	10.4	7.4	9.3	6.6	8.3	5.7	7.3	4.9	6.2
11	8.9	10.6	8.1	9.6	7.2	8.5	6.3	7.5	5.4	6.4
12	8.5	10.1	7.6	9.1	6.8	8.1	5.9	7.0	5.1	6.0
13	8.1	10.4	7.3	9.4	6.5	8.3	5.7	7.3	4.9	6.2
14	7.9	11.3	7.1	10.1	6.3	9.0	5.5	7.9	4.8	6.8
15	6.3	11.4	5.7	10.2	5.0	9.1	4.4	8.0	3.8	6.8

*Adapted from Hammond (1955a).

TABLE 5C

TRICEPS SKIN-FOLD, ADULTS, SEXES SEPARATE

Sex	Triceps skin-fold (mm)				
	Standard	90% standard	80% standard	70% standard	60% standard
Male	12.5	11.3	10.0	8.8	7.5
Female	16.5	14.9	13.2	11.6	9.9

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Fig. 2 Lange skinfold calipers in use for measurement of triceps skinfold thickness. In this patient the reading of 2mm is well below 60% of the standard for an adult female and indicates far advanced depletion of subcutaneous fat stores, as seen in prolonged protein-calorie malnutrition.

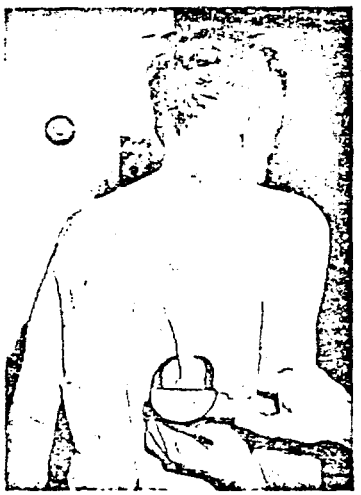

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Fig. 3 Lange skinfold calipers in use for measurement of subscapular skinfold thickness. In this patient the reading of 5 mm places the subject below 60% of the standard and thus indicates severe depletion.

TABLE 6A

ARM CIRCUMFERENCE, 6-17 YEARS, SEXES SEPARATE*

Arm circumference (cm)

Age (years)	Standard		90% standard		80% standard		70% standard		60% standard	
	M	F	M	F	M	F	M	F	M	F
6	17.3	17.3	15.6	15.5	13.8	13.8	12.1	12.1	10.4	10.4
7	17.8	17.8	16.0	16.0	14.2	14.2	12.5	12.5	10.7	10.7
8	18.4	18.4	16.5	16.6	14.7	14.7	12.9	12.9	11.0	11.1
9	19.0	19.1	17.1	17.2	15.2	15.3	13.3	13.4	11.4	11.5
10	19.7	19.9	17.7	17.9	15.8	15.9	13.8	13.9	11.8	11.9
11	20.4	20.7	18.4	18.6	16.3	16.5	14.3	14.5	12.2	12.4
12	21.2	21.5	19.1	19.3	16.9	17.2	14.8	15.0	12.7	12.9
13	22.2	22.4	20.0	20.2	17.7	17.9	15.5	15.7	13.3	13.4
14	23.2	23.2	20.9	20.9	18.6	18.5	16.3	16.2	13.9	13.9
15	25.0	24.4	22.5	22.0	20.0	19.5	17.5	17.1	15.0	14.6
16	26.0	24.7	23.4	22.2	20.8	19.7	18.2	17.3	15.0	14.8
17	26.8	24.9	24.1	22.3	21.4	19.9	18.8	17.4	16.1	14.9

*Adapted from O'Brien, Girshik & Hunt (1941).

TABLE 6B

ARM CIRCUMFERENCE, ADULTS, SEXES SEPARATE*

Arm circumference (cm)

Sex	Standard	90% standard	80% standard	70% standard	60% standard
Male	29.3	26.3	23.4	20.5	17.6
Female	28.5	25.7	22.8	20.0	17.1

*Adapted from O'Brien & Shelton (1941); Hertzberg et al. (1963).

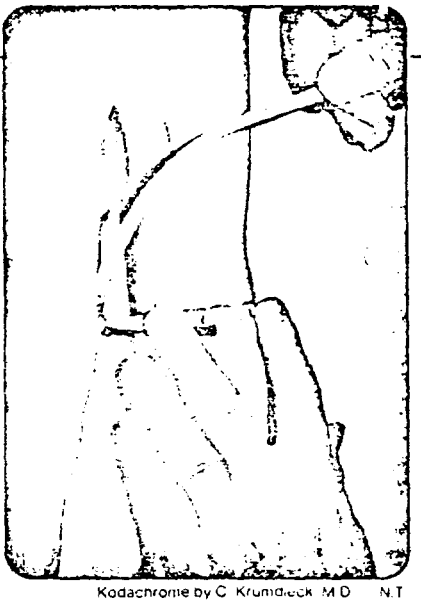

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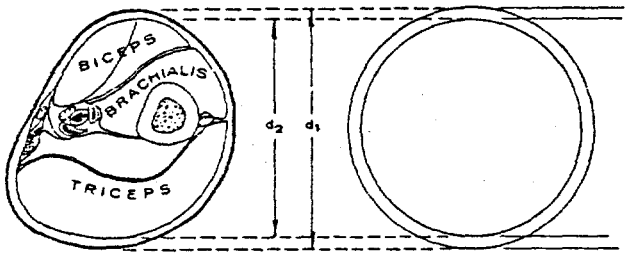
Fig. 4 Advance parietal muscle depletion in arms of 34 year old man 6'2" tall. At a weight of 84 lbs, he was approximately 50% below desirable weight. Arm circumference of 6¾ inches (13 cm) is below 60% of standard. Triceps skinfold thickness, 5 mm, is below 60% of standard. Mid-arm muscle circumference = 13 cm minus x 5 mm, = 13 cm - (3.14 x 0.5 cm) = 11.43 cm, which is below 60% of standard. Total serum protein and albumin levels were normal.



This reflects both caloric adequacy and muscle mass.

We have found the mid upper arm to be the most useful place and to give the optimal results. A soft tape measure calibrated in cm is used. It is placed around the left arm of its mid point (in the same place as previously described for triceps skinfold). It should be firmly wrapped around, but without compression of the underlying muscle. (See Figs. VI & VII for normal values derived from Jelliffe, 1966.)

CALCULATION OF MID-UPPER-ARM-MUSCLE CIRCUMFERENCE

This is derived from the mid upper arm circumference by means of a formula (from Jelliffe, 1966). (The diameter of the humerus is assumed to be constant.)

C_1 = mid upper arm circumference in cm
S = triceps skinfold in cm
d_1 = arm diameter
d_2 = muscle diameter
r = radius

Skinfold S = 2 × subcutaneous fat
$= d_1 - d_2$

Circumference $C_1 = 2\pi r$
$= \pi d_1$

Muscle Circumference $C_2 = 2\pi r$ cm
$= \pi d_2$ cm
$= \pi(d_1 - (d_1 - d_2))$ cm
$= \pi d_1 - \pi (d_1 - d_2)$ cm
$= C_1 - \pi S$ cm

TABLE 7A

MID-ARM-MUSCLE CIRCUMFERENCE, 6-60 MONTHS, SEXES SEPARATE

Mid-arm-muscle circumference (cm)

Age (months)	Standard		90% standard		80% standard		70% standard		60% standard	
	M	F	M	F	M	F	M	F	M	F
6	11.4	11.2	10.3	10.1	9.1	9.0	8.0	7.8	6.8	6.7
12	12.7	12.4	11.4	11.2	10.2	9.9	8.9	8.7	7.6	7.4
18	12.9	12.5	11.6	11.3	10.3	10.1	9.0	8.8	7.7	7.6
24	13.1	12.8	11.8	11.5	10.5	10.2	9.2	9.0	7.9	7.7
36	13.3	12.9	12.0	11.6	10.3	10.3	9.3	9.0	8.0	7.7
48	14.0	13.7	12.6	12.3	11.2	11.0	9.8	9.6	8.4	8.2
60	14.1	13.9	12.7	12.5	11.3	11.1	9.9	9.7	8.5	8.3

TABLE 7B

MUSCLE CIRCUMFERENCE, 6-15 YEARS, SEXES SEPARATE

Muscle circumference (cm)

Age (years)	Standard		90% standard		80% standard		70% standard		60% standard	
	M	F	M	F	M	F	M	F	M	F
6	14.7	14.2	13.2	12.8	11.8	11.4	10.3	9.9	8.8	8.5
7	15.3	14.8	13.8	13.3	12.2	11.8	10.7	10.4	9.2	8.9
8	16.0	15.3	14.4	13.8	12.8	12.2	11.2	10.7	9.6	9.2
9	16.5	15.9	14.9	14.3	13.2	12.7	11.6	11.1	9.9	9.5
10	17.1	16.6	15.4	14.9	13.7	13.3	12.0	11.6	10.3	10.0
11	17.6	17.3	15.8	15.6	14.1	14.1	12.3	12.1	10.6	10.4
12	18.5	18.3	16.6	16.5	14.8	14.6	12.9	12.8	11.1	11.0
13	19.6	19.1	17.6	17.2	15.7	15.3	13.7	13.4	11.8	11.5
14	20.8	19.6	18.7	17.6	16.6	15.7	14.6	13.7	12.5	11.8
15	23.0	20.8	20.7	18.7	18.4	16.6	16.1	14.6	13.8	12.5

TABLE 7C

MUSCLE CIRCUMFERENCE, ADULTS, SEXES SEPARATE

Muscle circumference (cm)

Sex	Standard	90% standard	80% standard	70% standard	60% standard
Male	25.3	22.8	20.2	17.7	15.2
Female	23.2	20.9	18.6	16.2	13.9

tion. Similarly, edema is a common feature in protein-calorie malnutrition and may give falsely high weight readings. Numerous other pathological states may also cause edema and intertere with nutritional assessment. However, edema usually indicates an underlying metabolic malfunction that must be taken into consideration in the overall nutritional assessment.

The choice of scales is most important. Spring balance scales are not sufficiently accurate for this type of work and should not be used. The best type of balance scale is the beam or lever balance type, provided it is checked periodically. We usually weigh patients in indoor clothing. Patients who are unable to stand can be weighed on bed-scales (see Figure 1). It is important to weigh patients daily at approximately the same time and under conditions that are as standardized as possible.

Cooperative children and adults are measured against the vertical measuring rod with a headpiece. Shoes are permitted allowing 1-inch heels for men and 2-inch heels for women. The lower border of the orbit should be in the same horizontal plane as the external auditory meatus and the arms should be by the sides. The bar of the headpiece should make contact with the scalp. Uncooperative children and bedridden patients may be measured recumbent using a wooden length board and perpendicular headpiece, or even tape measure.

For calculation of ideal weight, we use the Metropolitan Life Insurance Company tables of desirable weight according to height and frame derived from the Build and Blood pressure study in 1959 (see Table 4.) Appropriate allowances must be made if the patient is not wearing ordinary clothes or shoes.

So far, we have attempted to describe simple clinical procedures that should be widely available. There are a number of routine laboratory procedures available in most hospitals which can also yield remarkably accurate information about nutritional status. The key is merely the adoption of a slightly different perspective and a slightly modified approach to the interpretation of laboratory results. For example, abnormally low levels of prothrombin activity, serum calcium and serum carotene, may each have a separate explanation. Collectively, however, they may well be the result of abnormal fat absorption affecting the functional status of the patient with regard to the fat-soluble vitamins A, D, and K.

We wish to emphasize that there is nothing magical about nutritional assessment and there is no single specific test that will provide all the answers. Nevertheless, simple laboratory procedures, available routinely in most hospitals, can yield highly useful information if the physician interprets them in their over-all relationship to the patient's status.

In addition to the simple tests already mentioned and presented in Table 1, there are a number of specialized procedures to aid in the precise characterization of status with regard to specific nutrients. Some are listed in Table 10. It should be borne in mind that many of these have been designed for screening studies in large populations and may have limited applicability to individual patients under unusual circumstances in the hospital. Recent therapy with minerals, drugs or vitamins may influence the outcome of laboratory studies. Certain antibiotics may inhibit growth of bacteria in bacterial assay systems for vitamins; contraceptive steroid agents may spuriously elevate vitamin A levels, reduce certain metal binding proteins, and lead to lowered circulating levels of folate, vitamin B-12, and other vitamins in some cases. Clinical scurvy may exist in the presence of serum ascorbate levels that are only in the "marginal" range. As with virtually all laboratory tests, it is essential to know the vagaries of the procedure, and the clinical implications of the result in relation to a comprehensive analysis of the patient's current situation.

Bodily Defense Breakdown Parameters

The body defenses are divided into 3 main categories:

1) *Mechanical*—The body is protected from microbial invasion not only by intact epithelial surfaces, but also by mucous barriers, digestive enzymes and excretory antibodies present on such surfaces. These cells, like all others, require an adequate supply of nutrients for their growth, turnover, and function.
2) *Cellular*—Cellular defense mechanisms are mediated by a) lymphocytes and plasma cells, but their exact function and modes of action are not well understood; and b) polymorphonuclear leukocytes which have the ability to ingest and destroy bacteria or foreign bodies.
3) *Humoral*—Humoral defense mechanisms are mediated by gammaglobulins or other plasma proteins which aid in the destruction of micro-organisms. Some antibodies appear in secretions; for example, in tears, colostrum, and intestinal mucus.

There is ample recent evidence that in protein calorie malnutrition, all three defense mechanisms are impaired. Hence, in addition to other serious disorders, the body is open to infection at a time when it is least able to cope with it. Changes in humoral and cellular defenses in protein calorie malnutrition are the subject of considerable research at the moment.

STANDARD PARAMETERS	>90%	60-90%	<60%
Weight/Height	123		
Triceps Skinfold	120		
Mid-Upper Arm Circum.	114		
Mid-Upper Arm Muscle Circumference	117		
ALBUMIN			
Admission	106		
5 days Post-op		71	
15 days Post-op	108		
HEIGHT/CREATININE	93		
LYMPHOCYTES			
Admission	120		
5 days Post-op			45
15 days Post-op	113		
TRANSFERRIN			
5 days Post-op		71	
CMI			
5 days Post-op			25
15 days Post-op		75	

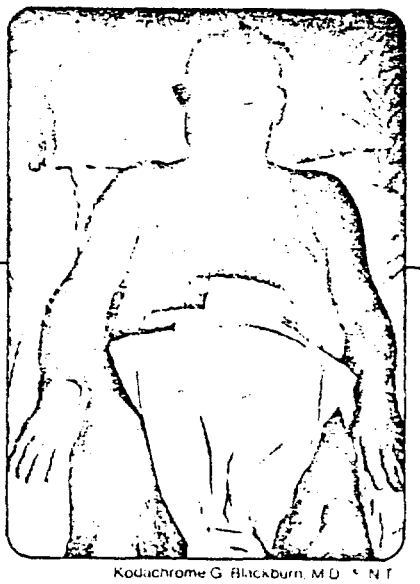


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Fig. 5 An example of acute visceral attrition, or an adult "Kwashiorkor-like" syndrome. This 57 year old man underwent surgery for a ruptured appendix and was maintained for approximately one week on 5 % dextrose infusions. Although he maintained acceptable anthropometric readings, he developed acute depression of serum albumin, transferrin, lymphocytes and cell-mediated immunity. These values all improved during the next ten days, while he recieved infusions of 3% amino acids to spare endogenous protein losses.

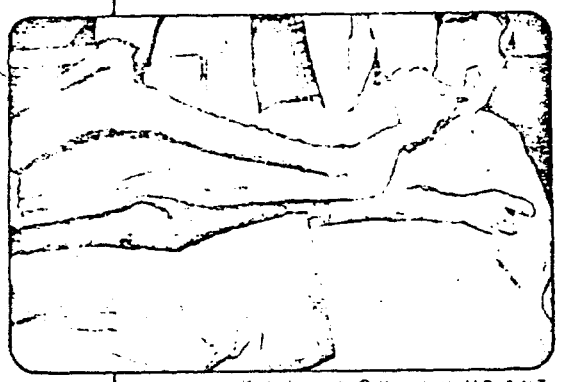

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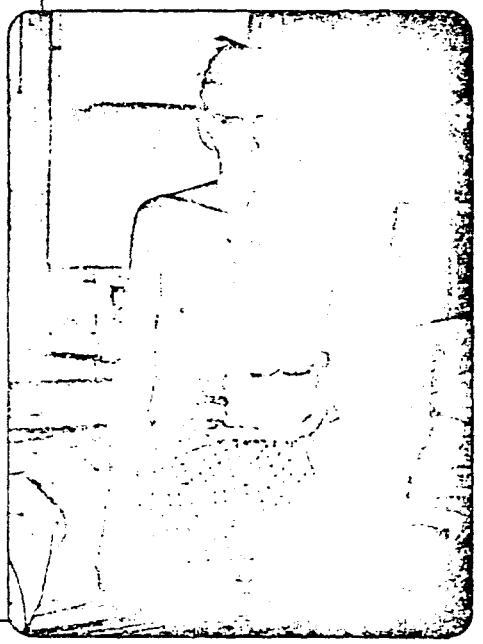
Fig. 6 Advanced parietal muscle depletion, or adult marasmus, in a 34 year old male following total gastrectomy for chemical injury and multiple complications. In spite of profound depletion of fat stores and muscle, the levels of serum albumin and transferrin are usually maintained at relatively normal levels until late in the clinical course. Although the height/creatinine ratio was not available in this subject, the serum creatinine was subnormal (0.4 mg%) compatible with a diminished muscle mass.

STANDARD PARAMETERS	>90%	60-90%	<60%
Weight/Height			49
Triceps Skinfold			<60
Mid-Arm Circum.			<60
Mid-Arm Muscle Circum.			<60
ALBUMIN	100		
LYMPHOCYTES			44
TIBC		64	
Cell-mediated immunity (not available)			

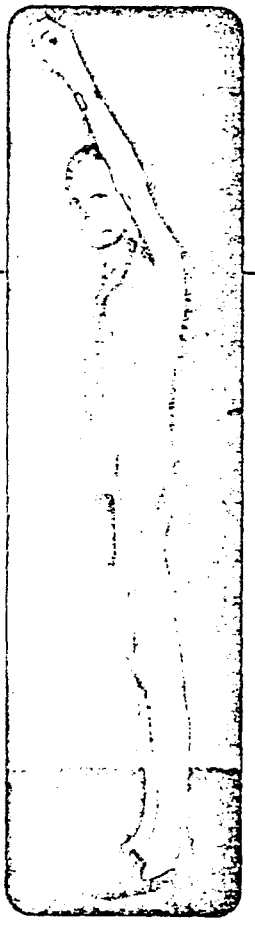
STANDARD PARAMETERS	>90%	60-90%	<60%
Weight/Height		83	
Triceps Skinfold		72	
Mid-Upper Arm Circum.		82	
Mid-Upper Arm Muscle Circum.		83	
ALBUMIN			
Admission	109		
7 days Post-op	91.5		
60 days Post-op		80	
80 days Post-op	91		
100 days Post-op		80	
HEIGHT/ CREATININE		66	
LYMPHOCYTES			
Admission		61	
80 days Post.op			
100 days Post-op			55
TRANSFERRIN			
Admission		80	
100 days Post-op			57
CMI			
7 days Post-op		60	
60 days Post-op		60	
100 days Post-op			50

Fig. 7 Acute visceral attrition superimposed on chronic parietal muscle depletion (combined "marasmic-Kwashiorkor-like" syndrome) in a 62 year old man. This man had undergone revision of a Polya-type gastrectomy to a Billroth-I anastomosis, because of postgastrectomy steatorrhea and afferent loop syndrome. His course was complicated by gastric retention and pneumonia. His already-limited reserves were further depleted by these complications.



Kodachrome, G. Blackburn, M.D. •

STANDARD PARAMETERS	>90%	60-90%	<60%
Weight/Height		64	
Triceps Skinfold	(not available)		
Mid-Arm Circum.	(not available)		
Mid-Arm Muscle Circum.	(not available)		
ALBUMIN			
Admission		80	
1 week		68	
4 weeks	91		
LYMPHOCYTES		66	
TIBC	100		
OTHER			
Serum carotene	14μg % (normal >40)		
Serum calcium	3.9 mEq/1 (normal 4.5-5.2)		
Fecal fat	41 g/day (normal <7.0 g/day)		



Kodachrome by C. E. Butterworth, M.D. • N.T.

Fig. 8 General appearance of a patient with protein-calorie malnutrition of arms, buttocks, and thighs, skin pigmentation and pedal edema. This is an example of a "Kwashiorkor-like" syndrome developing after a prolonged period of adult marasmus or parietal muscle depletion. Also see Fig. 9

Methods of Evaluating Bodily Defenses

A. Quantitatively

1) Total white cell count in a normal person is usually in the range of 5 - 10,000 per cubic mm.

2) Differential Counts

a. Lymphocytes usually account for 30% of the normal differential white count and they should be present in absolute numbers of at least 1,500/cubic mm. Lower levels indicate impaired cellular defense mechanisms which occur in protein calorie malnutrition.

b. Polymorphonuclear leukocytes usually account for 65% of the total white cell count. With pyogenic infection, a polymorphonuclear leukocytosis occurs and there is an increase in the proportion of non-segmented ("stab") forms. A failure to respond to pyogenic infection with a polymorphonuclear leukocytosis means a

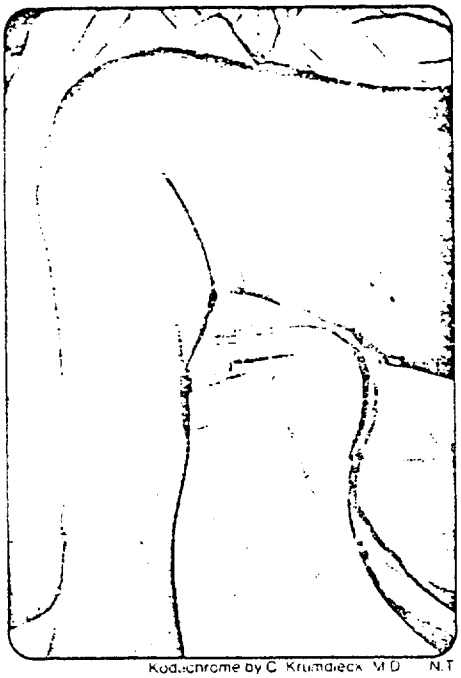


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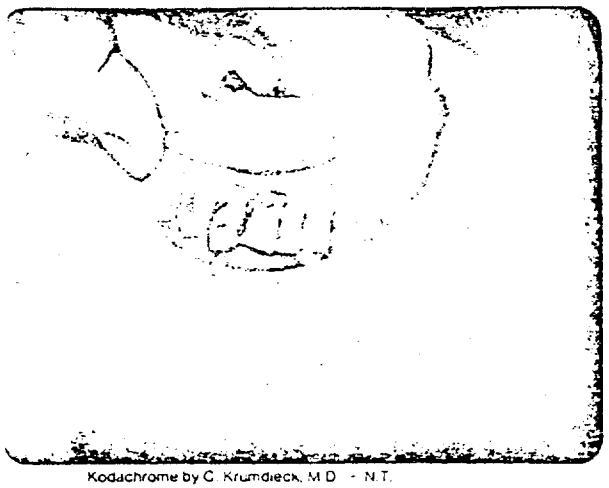
Fig. 9 Resorption of gastrocnemius muscle in an obese subject, who had lost 60 lbs of body weight in 60 days (from 320 to 260) during a complicated postoperative period following cholecystectomy. There had been marked limitation of nutrient intake. Total serum protein was 5.4, albumin 2.4 g/dl along with numerous other abnormal laboratory findings. The general appearance and abundant subcutaneous fat tended to obscure extensive loss of lean body mass. Nutritional assessment was protein-calorie malnutrition, severe. (acute visceral attrition superimposed on chronic parietal muscle depletion; "Marasmic-Kwashiorkor-like syndrome").



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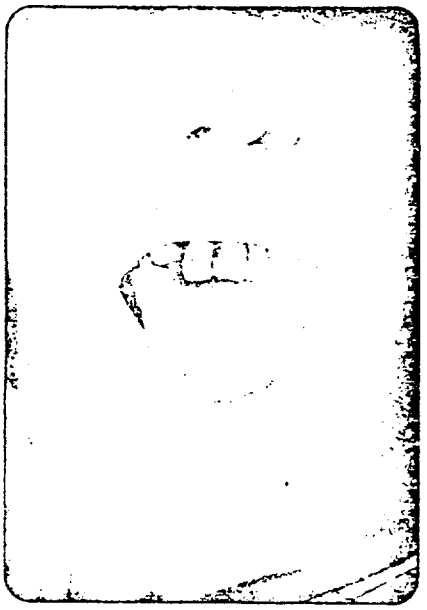
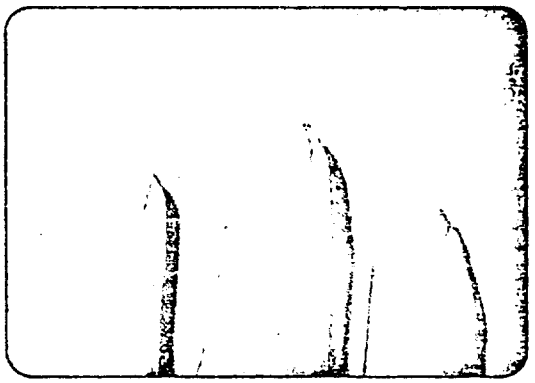
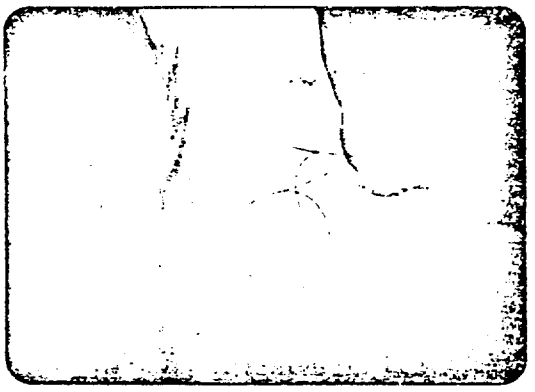


Fig. 11 Cheilosis, glossitis, scorbutic gums and periodontal disease in a patient with multiple deficiencies of vitamins and iron due to inadequate intake. She had eaten nothing but canned soup for 4 months and had pulled several of her own teeth when they became loose. Hospitalization was brought about by an acute urinary tract infection, probably facilitated by impaired immune mechanisms. The clinical diagnosis of scurvy was confirmed by a plasma ascorbate value in the deficient range. Other features of malnutrition included: iron deficiency anemia (low serum iron and low transferrin saturation), hypoproteinemia, hypoalbuminemia, hypoprothrombinemia, and subnormal levels of thiamin in blood and urine. Despite cheilosis, the riboflavin levels in blood and urine were in the acceptable range. There was rapid and dramatic improvement in her general state following replacement therapy with multiple vitamins and iron, along with treatment of infection. Dental extractions were carried out successfully after correction of nutritional deficiencies. However, she would have run a considerable risk of postoperative complications, if dental surgery (or any other surgery) had been attempted without adequate prior preparation. She illustrates the value of early assessment of nutritional status.

Fig. 10 Nail changes during PCM. A 36-year-old man developed an enterocutaneous fistula following an injury, lost approximately 40% of his body weight and developed multiple nutritional deficiencies. This illustration shows abnormal nail, characterized by brittleness and lack of luster, being displaced by normal nail that has grown during a period of total parenteral nutrition.





Kodachrome by C. Krumdieck, M.D. - N.T.

Fig. 12 Easily pluckable hair. Gentle traction on hair between thumb and forefinger, sliding toward the tip, normally yields no hairs or at most one or two. In cases of PCM larger numbers are released and with greater ease. Although this is difficult to quantitate, it becomes possible with experience to distinguish between "easily pluckable" and firmly attached hair, making this simple procedure a useful adjunct in the bedside evaluation of a patient's status. Valuable information can sometimes be gained by inspection of the comb or brush at the bedside for evidence of excessive shedding of hair.

poor prognosis, especially in a protein calorie malnutrition.

3) *Total Protein, Protein Electrophoresis*

Total protein 6 - 8 gm/100 ml

Albumin 50 - 65% Total = 3.0 - 4.5 gm/100 ml

Globulin (contains antibodies) 35 - 51% Total - 3.0 - 4.5 gm/100 ml

Transferrin (Siderophilin) - A beta-globulin which has been the subject of considerable interest as a parameter to judge protein calorie malnutrition.

The serum concentration of transferrin can be quantitated in the laboratory, but the procedure is not yet widely available. Depressed transferrin levels should be suspected whenever the total iron binding capacity (TIBC) is less than 250 µg %.

Recent work suggests that the plasma proteins synthesized with the highest priority during recovery from PCM are the immunoglobulins.

Next in priority are certain coagulation proteins, (prothrombin and proconvertin), pre-albumin, retinol-binding protein, and beta-lipoprotein apopeptide. Albumin, transferrin, and hemoglobin appear somewhat later. Further research is necessary to establish serum transferrin as a useful parameter in the assessment of nutritional status, but early results are encouraging.

B. Qualitatively

1) *Lymphocyte* quality evaluation can be carried out *in vitro* using a variety of techniques to determine their competency, such as their ability to undergo "blast-transformation" in response to phytohemagglutinin.

Height Creatinine

The 24-hour urinary excretion of creatinine bears a good relationship to the body's muscle mass, although it tends to be higher with high dietary intake of lean meat.

The results are expressed as mg creatinine in 24 hours per/cm of body height.

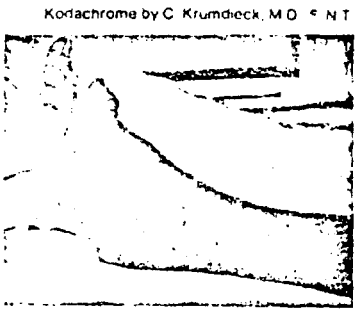
A height creatinine index can be derived by taking:

#No. of mg creatinine/24 hrs/cm height
#No. of mg creatinine in man or women
of ideal weight for similar height/24 hrs/cm height

It can be easily expressed as a percentage by multiplying $\times \frac{100}{1}$

The creatinine excretion of patients with protein-calorie malnutrition is lower than normal persons, indicating that in protein-calorie malnutrition the muscle mass is subnormally developed.

(See tables for values)



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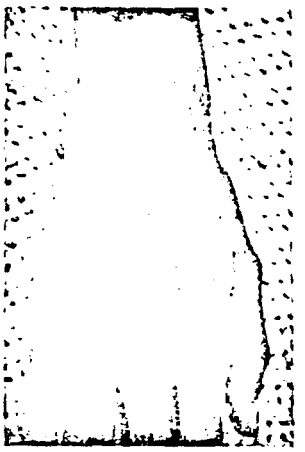


Fig. 15 Hand and foot of a 46 year-old man with pellegra. Notice erythemia, hyperpigmentation, desquamation, and sharp margination.

TABLE 8

REFERENCE TABLE FOR MEN OF IDEAL WEIGHT FOR THEIR HEIGHT OF URINARY
CREATININE/CM BODY HEIGHT
CREATININE CO-EFFICIENT—23mg/kg/BODY WEIGHT

Height			Medium Frame Ideal Weight		Total MG	MG Creatinine/CM
Ft.	In.	cm	lb	kg	Creatinine/24 Hrs	Body Height/24 Hrs
5'	2"	157.5	124	56	1288	8.17
5'	3"	160	127	57.6	1325	8.28
5'	4"	162.6	130	59.1	1359	8.36
5'	5"	165.1	133	60.3	1386	8.40
5'	6"	167.6	137	62	1426	8.51
5'	7"	170.2	141	63.8	1467	8.62
5'	8"	172.7	145	65.8	1513	8.76
5'	9"	175.3	149	67.6	1555	8.86
5'	10"	177.8	153	69.4	1596	8.98
5'	11"	180.3	158	71.4	1642	9.11
6'	0"	182.9	162	73.5	1691	9.24
6'	1"	185.4	167	75.6	1739	9.38
6'	2"	188	171	77.6	1785	9.49
6'	3"	190.5	176	79.6	1831	9.61
6'	4"	193	181	82.2	1891	9.80

TABLE 9

REFERENCE TABLE FOR WOMEN OF IDEAL WEIGHT FOR THEIR HEIGHT OF URINARY
CREATININE/CM BODY HEIGHT
CREATININE CO-EFFICIENT—18mg/kg/BODY WEIGHT

Height			Medium Frame Ideal Weight		Total MG	MG Creatinine/CM
Ft.	In.	cm	lb	kg	Creatinine/24 Hrs	Body Height/24 Hrs
4'	10"	147.3	101.5	46.1	830	5.63
4'	11"	149.9	104	47.3	851	5.68
5'	0"	152.4	107	48.6	875	5.74
5'	1"	154.9	110	50	900	5.81
5'	2"	157.5	113	51.4	925	5.87
5'	3"	160	116	52.7	949	5.93
5'	4"	162.6	119.5	54.3	977	6.01
5'	5"	165.1	123	55.9	1006	6.09
5'	6"	167.6	127.5	58	1044	6.23
5'	7"	170.2	131.5	59.8	1076	6.32
5'	8"	172.7	135.5	61.6	1109	6.42
5'	9"	175.3	139.5	63.4	1141	6.51
5'	10"	177.8	143.5	65.2	1174	6.60
5'	11"	180.3	147.5	67	1206	6.69
6'	0"	182.9	151.5	68.9	1240	6.78

plan. Briefly, an adult with kwashiorkor has adequate reserves of fat and skeletal muscle that can contribute to his needs, if he is given appropriate amounts of fluid, electrolytes, vitamins, minerals and enough protein to offset obligatory nitrogen losses associated with the illness or injury. Alternative intravenous and post-operative diets have recently been developed which minimize these losses and conserve visceral protein, by providing an exogenous supply of calories and amino acids.

The adult marasmic patient can benefit from vigorous oral feeding programs, if adequate time is available and if depletion is not far-advanced. Generally speaking, however, patients who are more than 20 or 30% below desirable weight, cannot recover on an ordinary meal pattern and must have aggressive support (such as around-the-clock tube feedings, gastrostomy, or substantial intravenous supplementation.)

The third category of marasmic, "kwashiorkor-like" patients requires vigorous hyperalimentation, either oral or parenteral or both. Nutritional support must be given promptly, if significant morbidity and mortality are to be avoided.

Examples of these three major forms of protein calorie malnutrition are presented in Figures 5, 6, and 7.

This has been an attempt to present, in a form suitable for general use, some simple and widely-available procedures for the assessment of nutritional status of hospitalized patients. We are aware that malnutrition is often a complex medical and socio-economic problem, and that our approach may err on the side of over-simplification. Nevertheless it is our hope that more widespread use of even these simple clinical and laboratory methods of assessment will bring about greater appreciation for the importance of good nutrition in the main-

Kodachrome by C. Krumdieck, M.D. • N.T.

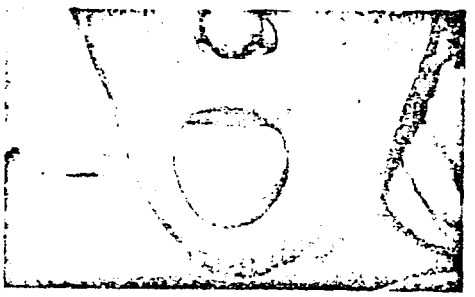


Fig. 16 The tongue of a 25 year-old woman with multiple nutritional deficiencies seven months after ileal by-pass surgery for obesity had been performed. The patient complained of a sore, dry tongue and lack of taste. She subsequently was found to have abnormally low levels of serum zinc and folate.

tenance of health and recovery from illness or injury. Furthermore, it is our conviction that simple adherence to basic diagnostic and therapeutic principles of nutrition will lead to great improvements in the overall quality of health care in our hospitals. More than that!—At times the results will seem nothing short of astonishing.

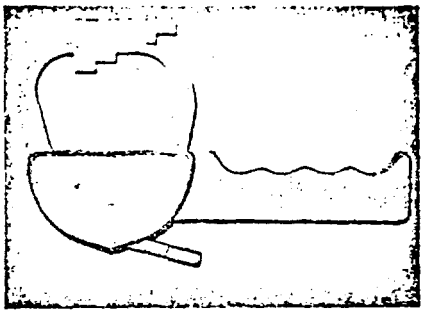
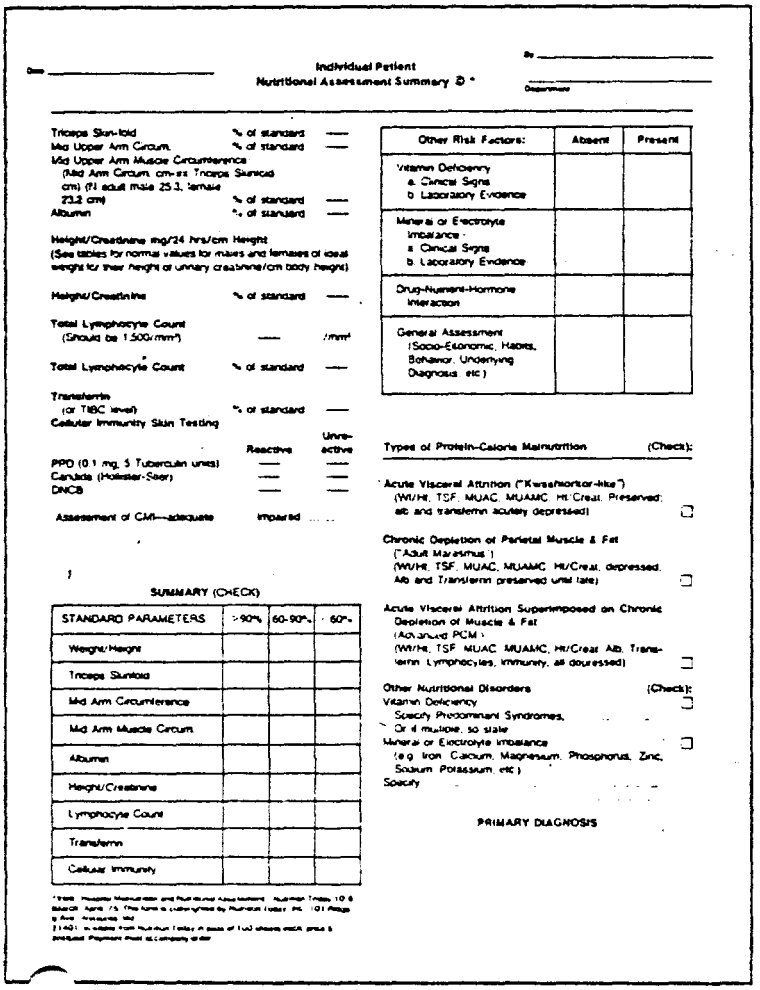


Fig. 17 Lange skinfold calipers, with standardization device*

*Manufactured by Cambridge Scientific Industries, Inc., Cambridge, Maryland



Individual Patient
Nutritional Assessment Summary ✪ *

Triceps Skin-fold	% of standard	—
Mid Upper Arm Circum.	% of standard	—
Mid Upper Arm Muscle Circumference (Mid Arm Circum. cm-ex. Triceps Skinfold cm) (ft adult male 25.3, female 23.2 cm)	% of standard	—
Albumin	% of standard	—
Height/Creatinine mg/24 hrs/cm Height (See tables for normal values for males and females of ideal weight for their height or urinary creatinine/cm body height)		
Height/Creatinine	% of standard	—
Total Lymphocyte Count (Should be 1,500/mm³)	—	/mm³
Total Lymphocyte Count	% of standard	—
Transferrin (or TIBC level)	% of standard	—

Cellular Immunity Skin Testing

	Reactive	Unreactive
PPD (0.1 mg, 5 Tuberculin units)	—	—
Candida (Hollister-Steer)	—	—
DNCB	—	—

Assessment of CMI—adequate ____ impaired ____

Other Risk Factors:	Absent	Present
Vitamin Deficiency a. Clinical Signs b. Laboratory Evidence		
Mineral or Electrolyte Imbalance a. Clinical Signs b. Laboratory Evidence		
Drug-Nutrient-Hormone Interaction		
General Assessment (Socio-Economic, Habits, Behavior, Underlying Diagnosis, etc.)		

Types of Protein-Calorie Malnutrition (Check):

Acute Visceral Attrition ("Kwashiorkor-like") (Wt/Ht, TSF, MUAC, MUAMC, Ht/Creat. Preserved; alb. and transferrin acutely depressed) ☐

Chronic Depletion of Parietal Muscle & Fat ("Adult Marasmus") (Wt/Ht, TSF, MUAC, MUAMC, Ht/Creat. depressed; Alb. and Transferrin preserved until late) ☐

Acute Visceral Attrition Superimposed on Chronic Depletion of Muscle & Fat (Advanced PCM) (Wt/Ht, TSF, MUAC, MUAMC, Ht/Creat, Alb, Transferrin, Lymphocytes, immunity, all depressed) ☐

Other Nutritional Disorders (Check):
Vitamin Deficiency ☐
Specify Predominant Syndromes, Or if multiple, so state
Mineral or Electrolyte Imbalance ☐
(e.g. Iron, Calcium, Magnesium, Phosphorus, Zinc, Sodium, Potassium, etc.)
Specify

PRIMARY DIAGNOSIS

SUMMARY (CHECK)

STANDARD PARAMETERS	>90%	60-90%	<60%
Weight/Height			
Triceps Skinfold			
Mid Arm Circumference			
Mid Arm Muscle Circum.			
Albumin			
Height/Creatinine			
Lymphocyte Count			
Transferrin			
Cellular Immunity			

TABLE 10

SPECIAL LABORATORY TESTS OF VALUE IN NUTRITIONAL ASSESSMENT

Nutrient and Units	Age of Subject (years)	Criteria of Status: Deficient	Marginal	Acceptable
*Serum Ascorbic Acid (mg/100 ml)	All ages	Up to 0.1	0.1-0.19	0.2+
*Plasma vitamin A (mcg/100 ml)	All ages	Up to 10	10-19	20+
*Plasma Carotene (mcg/100 ml)	All ages	Up to 20	20-39	40+
	Pregnant	—	40-79	80+
**Serum Folacin (ng/ml)	All ages	Up to 2.0	2.1-5.9	6.0+
**Serum vitamin B_{12} (pg/ml)	All ages	Up to 100	—	100+
*Thiamine in Urine (mcg/g creatinine)	1-3	Up to 120	120-175	175+
	4-5	Up to 85	85-120	120+
	6-9	Up to 70	70-180	180+
	10-15	Up to 55	55-150	150+
	16+	Up to 27	27- 65	65+
	Pregnant	Up to 21	21- 49	50+
*Riboflavin in Urine (mcg/g creatinine)	1-3	Up to 150	150-499	500+
	4-5	Up to 100	100-299	300+
	6-9	Up to 85	85-269	270+
	10-16	Up to 70	70-199	200+
	16+	Up to 27	27- 79	80+
	Pregnant	Up to 30	30- 89	90+
**RBC Transketolase-TPP-effect (ratio)	All ages	25+	15- 25	Up to 15
**RBC Glutathione Reductase-FAD-effect (ratio)	All ages	1.2+	—	Up to 1.2
**Tryptophan Load (mg Xanthurenic acid excreted)	Adults (Dose: 100mg/kg body weight)	25+(6 hrs.) 75+(24 hrs.)	— —	Up to 25 Up to 75
**Urinary Pyridoxine (mcg/g creatinine)	1-3	Up to 90	—	90+
	4-6	Up to 80	—	80+
	7-9	Up to 60	—	60+
	10-12	Up to 40	—	40+
	13-15	Up to 30	—	30+
	16+	Up to 20	—	20+
*Urinary N'methyl nicotinamide (mg/g creatinine)	All ages	Up to 0.2	0.2-5.59	0.6+
	Pregnant	Up to 0.8	0.8-2.49	2.5+
**Urinary Pantothenic Acid (mcg)	All ages	Up to 200	—	200+
**Plasma vitamin E (mg/100 ml)	All ages	Up to 0.2	0.2-0.6	0.6+

*Adapted from the Ten State Nutrition Survey

**Criteria may vary with different methodology

Derived from Table of Current Guidelines for Criteria of Nutritional Status for Laboratory Evaluation in: Nutritional Assessment in Health Programs. Am. J. Public Health (Supp.) 63: 34, 1973, G. Christakis, Editor.

Also see: Sauberlich, H.E., Dowdy, R.P. and Skala, J. H. Laboratory Tests for the Assessment of Nutritional Status in: Critical Reviews in Clinical Laboratory Science 4: 215-340, 1973.

APPENDIX B

LETTER TO THE ORTHOPEDIC SURGEONS

Ball Memorial Hospital's Nutritional Support Team is interested in researching an intervention that could possibly improve the outcome for elderly hip fracture patients requiring surgery. After doing a great deal of research, we have discovered two phenomena. First, hip fractures in the elderly carry unusually high morbidity and mortality rates. Second, a large part of the elderly population do not eat adequately. Unfortunately, following injury when nutrition may be especially important for an acceptable outcome, many elderly still do not receive sufficient nutrition. Thus, we find it not unreasonable to believe that nutrition in the elderly may play a major role in determining their outcome following a hip fracture. Unfortunately, very little research has been done to discover the implications of this possible correlation.

Therefore, we would like to conduct a pilot study at Ball Memorial Hospital testing this theory. The study would be performed by placing most elderly hip fracture patients requiring surgery in either an experimental group, receiving supplemental feedings, or in a control group, being monitored without receiving supplemental feedings.

The possible implications of this controlled trial of artificial feeding could be of immense benefit to elderly hip fracture patients in the future. The research proposal for the pilot study is enclosed for you to peruse at your convenience.

Please sign the conceptual agreement below and return to me as soon as possible. Thank-you for your time and cooperation.

Sincerely,

N. C. Turner, M.D.

I,_____, as an orthopedic surgeon agree in concept with this study and its possible positive implications. In the course of events that this study is performed, I will request the Nutritional Support Team be put on the case of every hip fracture patient requiring surgery that is aged 65-80 years. I also will allow Corpak tube feedings to be initiated when determined as needed by the team.

_____

(signature)

APPENDIX C

INFORMATION FOR SUBJECTS AND CONSENT FORM

This research entitled, "Nurtrition and Hip Fractures in the Elderly", is a study on the effects of nutrition on the outcome of hip fracture patients. We are interested in discovering if good nutrition improves the outcome following hip fracture surgery in an elderly patient.

Following an initial nutritional assessment, you will be placed in either an experimental group, receiving supplemental feedings, or in a control group, not receiving supplemental feedings. You will be monitored daily while hospitalized; after discharge you will receive a telephone call every two months for up to six months. The monitoring while in the hospital will consist of checking lab values and physically assessing, and the telephone calls will consist of questions about your progress.

The supplemental feedings will be administered through nasogastric Corpak feeding tubes, which are safely tolerated by most patients. The occurrence of associated complications is acceptably low. There is a chance you will experience mechanical tube complications, gastrointestinal upset, or fluid and electrolyte imbalances. However, the risk for complications is minimal, and precautionary measures to prevent complications will be implemented. Also, the tube will be inserted by qualified personnel.

If you receive the supplemental feedings, it may significantly improve your outcome. You also will benefit from knowing that you have helped increase the knowledge about what contributes to the outcome of hip fracture surgery on the elderly.

The information obtained during the study will under no circumstances be publicly disclosed in a manner that would identify any specific person. Identification numbers will be substituted for the subjects' names on study records to prevent any accidental breach of confidentiality.

This information is intended to familiarize you with the procedures, risks, and benefits associated with this project. If you have any questions, either now or in the future, feel free to ask them. It is also understood that you are free to withdraw from this investigation at any time without any negative feelings or actions by the investigators.

Emergency medical treatment is available where an injury or illness is incurred in the course of the research study.

Informed Consent Statement

I,_____, agree to participate in this research project entitled, "Nutrition and Hip Fractures in the Elderly." I have had the study explained to me, and my questions have been answered to my satisfaction. I have read the description of this study and give my consent to participate. I will receive a copy of this consent form to keep for future reference.

_____
(Participant's Signature)

Principal Investigator:
N. C. Turner, M. D.
Nutritional Support Team physician
Ball Memorial Hospital
(317)747-3111